Ph.D. Coursework Syllabus

(Academic Year 2022-23)

Faculty of Science

JIS University
81, Nilgunj Road
Kolkata 700047
West Bengal
India

Department of Biosciences

Syllabus for Ph.D. Coursework

Sl. No.	Course code	Course	Credit points	Full marks	Course type#	Total credits	Total marks
UNIVERSITY PAPER (COMMON)						14	350
1	RPD1001	RESEARCH METHODOLOGY	4	100	C		
2	RPD1002	RESEARCH AND PUBLICATION ETHICS	2	50	C		
FACULTY PAPER (COMMON)							
3	RBT1001	METHODS IN BIOLOGY & COMPUTER APPLICATION	4	100	C		
		FACULTY PAPER (ELECTIVE)					
4	RBT1002	MICROBIAL GENETICS	4	100	M		
4	RBT1003	CANCER BIOLOGY	4	100	M		
4	RBT1004	ENZYMOLOGY	4	100	M		

 # C = COMMON COURSE; M = MAJOR COURSE

COURSE NAME: RESEARCH METHODOLOGY

COURSE CODE: RPD1001 **CREDIT POINTS: 4**

Content:

I. Research-Definition, Objectives of Research, What Makes People do Research? Qualities of a good Researcher, Limitations of Research, Views of Researchers, Scientific method of Research, Importance of Research, Illustrations of Research.

II. Process of Research. Research Methods, Research Methods versus Research Methodology. Fundamental or Basic Research and Examples, Applied Research and Examples, Differences between Basic Research and Applied research. Difference between Approach and Validity, Reliability versus Unbiased and objective, Research structured enquiry, Research Design.

III. Normal, Revolutionary, Quantitative, and Qualitative Research Methods. Learning from Qualitative and Quantitative Research. Data Collection, Generation of Data using Qualitative Methods: (Individual Interviews, Focus groups, Observations, Self-Study, Action Research), Sources of Quantitative Data, Analyzing Quantitative Data, Pros and Cons of Qualitative research, Comparing Quantitative and Qualitative Research, Example and Distinction, Important Difference, Qualitative research, Descriptive Versus Analytical, Conceptual Versus Empirical, Decision-oriented versus Conclusion-oriented,

IV. Process of literature Survey, Advantages and Pitfalls. The Internet as a Medium for Research, Availability of Scientific Research Information, Problems Encounter, Features of Conducting Research through Internet, New Challenges to Researchers, Potential Advantages of Online Questionnaire, Potential Difficulties, Preservation of References, Assessing the Current Status.

V. Ethics in Research, Computer Ethics, Some areas of Research Ethics, Essential information required for authority, Author Responsibilities, What is not acceptable? What are Plagiarism and Self-Plagiarism, Other Types of Ethical Violations, How Journals Detect and Handle Problem Papers? Example, Reasons for possible Plagiarism, appropriate authorship.

VI. Seminar, Oral Report, Quotation, Points to be Remembered in Preparing an Oral Report, Write-up of the oral presentation, Art of writing and layout of Research Paper or Article or Ph. D. Thesis. Main Text, End Matters, Content of work.

References:

1. Ander May, R., Meyer, V., Van Rys, J., Kemper, D., & Sebranek, P. (2016). The College Writer: A Guide to Thinking, Writing, and Researching, MIT Press.

2. Gustavii, B. (2014). How to Write and Illustrate a Scientific Paper. New York, NY: Cambridge.

3. Kothari, C.K. (2015). Research Methodology – Methods and Techniques. New Age International, New Delhi.

4. Krishnswamy, K.N., Shivkumar, AppaIyer, &Mathiranjan M. (2013). Management Research Methodology: Integration of Principles, Methods, and Techniques. Pearson Education, New Delhi.

5. G. Vijaylakshmi and C. Sivapragasam (2008). Research Methods: Tips and Techniques. MJP Publishers, Chennai.

COURSE NAME: RESEARCH AND PUBLICATION ETHICS

COURSE CODE: RPD1002 CREDIT POINTS: 2

Content:

I. PHILOSOPHY AND ETHICS

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

II. SCIENTIFIC CONDUCT

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

III. PUBLICATION ETHICS

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

IV. OPEN ACCESS PUBLISHING

1. Open access publications and initiatives
2. SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU

V. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

VI. PUBLICATION MISCONDUCT

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad
4. Use of plagiarism software like Turnitin, Urkund and other opensource software tools

VII. DATABASES AND RESEARCH METRICS

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

VIII. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g index, il 0 index, altimetric

References:

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967). A Short History of Ethics. London.
3. P. Chaddah (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized.
4. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009). On Being a Scientist: A Guide to Responsible Conduct in Research (Third Edition). National Academies Press.
5. Resnik, D. B. (2011). What is Ethics in Research & Why is it Important. National Institute of Environmental Health Sciences.
6. Beall, J. (2012). Predatory Publishers Are Corrupting Open Access. Nature, 489(7415), 179–179.
7. Indian National Science Academy (INSA) (2019). Ethics in Science Education, Research and Governance.

COURSE NAME: METHODS IN BIOLOGY & COMPUTER APPLICATION

COURSE CODE: RBT 1001 CREDIT POINTS: 4

UNIT-I: Molecular biology and recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels; molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems; expression of recombinant proteins using bacterial, animal and plant vectors; isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors; in vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms; protein sequencing methods, detection of post-translation modification of proteins; DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques; isolation, separation and analysis of carbohydrate and lipid molecules; RFLP, RAPD and AFLP techniques.

UNIT-II: Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

UNIT-III: Biophysical methods: Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

UNIT-IV: Microscopic techniques: Visulization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.

UNIT-V: Computer application: Basics of common application software packages for word processing (MS Word), spreadsheets (MS Excel) and presentation (MS Powerpoint). Introduction of Internet- LAN, MAN, WAN.

References:

1. Wilson And Walker's Principles And Techniques Of Biochemistry And Molecular BiologyRobinson, J. R., Lee V. H. L, Controlled Drug Delivery Systems, Marcel Dekker,Inc., New York, 1992. 3. Encyclopedia of controlled delivery, Editor- Edith Mathiowitz, Published by Wiley Interscience Publication, John Wiley and Sons, Inc, New York! Chichester/Weinheim, 2017.
2. Computational Biology: Methods and Applications by Daniel McGuire, 2018

COURSE NAME: MICROBIAL GENETICS

COURSE CODE: RBT 1002 CREDIT POINTS: 4

UNIT-I: Genome Organization & Plasmid

Genome organization: E. coli and general eukaryotic genome, Saccharomyces, Tetrahymena; Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 µ plasmid, Plasmid replication and partitioning, Host range, plasmid- incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids

UNIT-II: Mutation and Mutagenesis

Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations; Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes

UNIT-III: Mechanisms of Genetic Exchange

Transformation - Discovery, mechanism of natural competence; Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping; Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

UNIT-IV Phage Genetics & Transposable Elements

Features of T4 genetics, Genetic basis of lytic versus lysogenic switch of phage lambda; Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non-replicative transposition, Mu transposon; Uses of transposons and transposition.

References:

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.

COURSE NAME: MICROBIAL GENETICS

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COURSE NAME: CANCER BIOLOGY

COURSE CODE: RBT 1003 CREDIT POINTS: 4

UNIT-I: Cell Immortalization and Tumorigenesis:

Cancer cells need to become immortal in order to form tumors, Cell-physiologic stresses impose a limitation on replication, the proliferation of cultured cells is also limited by the telomeres of their chromosomes, Telomeres are complex molecular structures that are not easily replicated, Overview of the Cell Cycle, The retinoblastoma gene and cell cycle regulation, The DNA damage checkpoint, p53 and DNA damage, BRC1, BRC2 and DNA damage.

UNIT-II: Invasion and Metastasis:

Overview of the cytoskeleton, Cytoskeletal regulatory proteins, Cellular motility and metastasis, Intermediate filaments and metastasis, Overview of the ECM, Regulators of the tumor microenvironment.

UNIT-III: Cancer Prevention and Diagnosis:

Carcinogens and DNA damage, Epidemiology and Cancer, Genomic Screening, Infectious agents that cause cancer.

UNIT-IV: The Rational Treatment of Cancer:

The development and clinical use of effective therapies will depend on accurate diagnosis of disease, Surgery, radiotherapy, and chemotherapy are the major pillars on which current cancer therapies rest, Differentiation, apoptosis, and cell cycle checkpoints can be exploited to kill cancer cells, Functional considerations dictate that only a subset of the defective proteins in cancer cells are attractive targets for drug development, The biochemistry of proteins also determines whether they are attractive targets for intervention, challenges and opportunities on the road ahead.

References:

1. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

COURSE NAME: ENZYMOLOGY

COURSE CODE: RBT 1004 CREDIT POINTS: 4

UNIT-I. **Enzyme reaction physic-chemical fundaments**:

Chemical catalysis: thermodynamic and kinetics features; Functional groups structure/activity relationship. Active site structures and enzyme mechanisms. Classification of enzymes according to the mechanisms; Stereo specificity and stereoselectivity.

UNIT-II. **Catalytic strategies as adaptive mechanisms to overcome problems:**

Catalytic specificity and regulatory strategies: Allosteric regulation, Regulation by reversible and irreversible covalent modification.

UNIT-III. **Applied enzymology:**

Fundaments and strategies of enzymatic assays; Fundaments of proteins engineering; Catalytic antibodies (abzymes); Ribozymes; Production of enzymes in heterologous systems; Biotechnology applications.

References:

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
2. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989

Department of Chemistry
Syllabus for Ph.D. Coursework

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3	RCH1001	SPECTROSCOPY AND INSTRUMENTATION	4	100	C		
FACULTY PAPER (ELECTIVE)							
4	RCH1002	POLYMER AND MATERIALS CHEMISTRY	4	100	M		
5	RCH1003	SYNTHETIC ORGANIC CHEMISTRY	4	100	M		
6	RCH1004	SPECIAL TOPICS IN INORGANIC CHEMISTRY	4	100	M		

 # C = COMMON COURSE; M = MAJOR COURSE

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COURSE CODE: RPD1001 **CREDIT POINTS: 4**

I. Research-Definition, Objectives of Research, What Makes People do Research? Qualities of a good Researcher, Limitations of Research, Views of Researchers, Scientific method of Research, Importance of Research, Illustrations of Research.

II. Process of Research. Research Methods, Research Methods versus Research Methodology. Fundamental or Basic Research and Examples, Applied Research and Examples, Differences between Basic Research and Applied research. Difference between Approach and Validity, Reliability versus Unbiased and objective, Research structured enquiry, Research Design.

III. Normal, Revolutionary, Quantitative, and Qualitative Research Methods. Learning from Qualitative and Quantitative Research. Data Collection, Generation of Data using Qualitative Methods: (Individual Interviews, Focus groups, Observations, Self-Study, Action Research), Sources of Quantitative Data, Analyzing Quantitative Data, Pros and Cons of Qualitative research, Comparing Quantitative and Qualitative Research, Example and Distinction, Important Difference, Qualitative research, Descriptive Versus Analytical, Conceptual Versus Empirical, Decision-oriented versus Conclusion-oriented,

IV. Process of literature Survey, Advantages and Pitfalls. The Internet as a Medium for Research, Availability of Scientific Research Information, Problems Encounter, Features of Conducting Research through Internet, New Challenges to Researchers, Potential Advantages of Online Questionnaire, Potential Difficulties, Preservation of References, Assessing the Current Status.

V. Ethics in Research, Computer Ethics, Some areas of Research Ethics, Essential information required for authority, Author Responsibilities, What is not acceptable? What are Plagiarism and Self-Plagiarism, Other Types of Ethical Violations, How Journals Detect and Handle Problem Papers? Example, Reasons for possible Plagiarism, appropriate authorship.

VI. Seminar, Oral Report, Quotation, Points to be Remembered in Preparing an Oral Report, Write-up of the oral presentation, Art of writing and layout of Research Paper or Article or Ph. D. Thesis. Main Text, End Matters, Content of work.

References:

6. Ander May, R., Meyer, V., Van Rys, J., Kemper, D., & Sebranek, P. (2016). The College Writer: A Guide to Thinking, Writing, and Researching, MIT Press.
7. Gustavii, B. (2014). How to Write and Illustrate a Scientific Paper. New York, NY: Cambridge.
8. Kothari, C.K. (2015). Research Methodology – Methods and Techniques. New Age International, New Delhi.

9. Krishnswamy, K.N., Shivkumar, AppaIyer, &Mathiranjan M. (2013). Management Research Methodology: Integration of Principles, Methods, and Techniques. Pearson Education, New Delhi.

10. G. Vijaylakshmi and C. Sivapragasam (2008). Research Methods: Tips and Techniques. MJP Publishers, Chennai.

COURSE NAME: RESEARCH AND PUBLICATION ETHICS

COURSE CODE: RPD1002 CREDIT POINTS: 2

I. PHILOSOPHY AND ETHICS

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

II. SCIENTIFIC CONDUCT

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

III. PUBLICATION ETHICS

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

IV. OPEN ACCESS PUBLISHING

1. Open access publications and initiatives
2. SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU

V. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

VI. PUBLICATION MISCONDUCT

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad
4. Use of plagiarism software like Turnitin, Urkund and other opensource software tools

VII. DATABASES AND RESEARCH METRICS

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

VIII. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g index, il 0 index, altimetric

References:

8. Bird, A. (2006). Philosophy of Science. Routledge.

9. MacIntyre, Alasdair (1967). A Short History of Ethics. London.

10. P. Chaddah (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized.

11. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009). On Being a Scientist: A Guide to Responsible Conduct in Research (Third Edition). National Academies Press.

12. Resnik, D. B. (2011). What is Ethics in Research & Why is it Important. National Institute of Environmental Health Sciences.

13. Beall, J. (2012). Predatory Publishers Are Corrupting Open Access. Nature, 489(7415), 179–179.

14. Indian National Science Academy (INSA) (2019). Ethics in Science Education, Research and Governance.

COURSE NAME: SPECTROSCOPY AND INSTRUMENTATION

COURSE CODE: RCH1001 CREDIT POINTS: 4

I. Spectroscopy for Structure Elucidation

Principles and applications of spectroscopy for the structure elucidation of simple and compound molecules: UV-visible, FTIR, Raman, NMR spectroscopy: ^{1}H NMR, ^{13}C NMR, DEPT, ^{2}D NMR: NOESY, COSY, HETCOR, HOMCOR, INADEQUATE, other NMR active nuclei: ^{11}B, ^{13}C, ^{19}F, ^{31}P, Mass spectrometry: ESI, MALDI, HRMS techniques, fragmentation process, ESR, Atomic Absorption, Fluorescence, Phosphorescence, CD, and ORD.

II. Instrumentation Techniques: Fundamental Theory and Applications

Chromatography: TLC, column chromatography, ion exchange, affinity, GC, GPC, HPLC
Microscopy: Optical microscope, FESEM, HRTEM, AFM, confocal microscopy, fluorescence microscopy. Structure elucidation by X-ray diffraction, XPS, Cyclic Voltammetry, amperometry, TGA, DTGA, DSC, DLS, MALLS, Electrophoresis.

References

1. R. M. Silverstein and F.X. Webster, Spectroscopic Identification of Organic Compounds, 6th Edition (2003) John Wiley, New York.
2. D. H. Williams and I.F. Fleming, Spectroscopic Methods in Organic Chemistry, 4th Edition (1988), Tata-McGraw Hill, New Delhi
3. R. L. Pecsok, L. D. Shields, T. Cairns and L.C. Mc William, Modern Methods of Chemical Analysis, 2nd Edition (1976), John Wiley, New York.
4. G. D. Christian, Analytical Chemistry, 5th Edition (1994), John Wiley & Sons, New York.
5. D. A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Analytical Chemistry - An Introduction, 7th Edition (2000), Saunders College Publishing, Philadelphia, London.
6. J. H. Kennedy, Analytical Chemistry: Principles, 2nd Edition (1990), Saunders Holt, London.
7. A. J. Bard, Electroanalytical Chemistry
8. H.A. Strobel, Chemical Instrumentation: A Schematic Approach, 2nd Edition (1973)

COURSE NAME: POLYMER AND MATERIALS CHEMISTRY

COURSE CODE: RCH1002 CREDIT POINTS: 4

I. Polymer synthesis: Fundamentals, different polymerization techniques and their detailed kinetics, controlled/living polymerization techniques and their applications, controlled radical polymerization: NMP, RAFT, ATRP, degenerative transfer polymerization, TERP, metal free thermal and photo-polymerization, co-ordination polymerization, metallocene polymerization, copolymerization, hyperbranched polymers synthesis and importance, sequence and stereo-controlled polymer synthesis, biodegradable polymers, and hybrid materials based on polymers.

II. Material synthesis and their characterization techniques:

Fundamental concepts, different synthetic strategy of metal/metal oxide/semiconducting materials, template based synthesis, size, shape and dimension controlled synthesis, growth kinetics, composite nanostructures, characterization of synthesized materials, properties and applications of different nanomaterials in the field of optoelectronic, mechanical, magnetic, and catalysis.

Recommended Books

1. G. Odian, Principles of Polymerization, 3rd Edition (1991), John Wiley, Singapore
2. F. W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Willey-Interscience, NY
3. C. Tanford, Physical Chemistry of Macromolecules
4. P. Bahadur, N.V. Sastry, Principle of Polymer Sciences, Narosa Publishing House, New Delhi
5. V.R. Gowarikar, N.V. Vishwanathan, J. Shreedhar, Polymer Sciences, Wiley Eastern, New Delhi
6. C. N. R. Rao, A. Müller, A. K. Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications, Vols 1 and 2, Wiley-VCH, Weinheim, 2004
7. C. Bréchignac, P. Houdy, M. Lahmani, Nanomaterials and Nanochemistry, Springer, London, 2006.
8. G. Cao, Nanostructures & Nanomaterials, Synthesis, Properties & Applications, Imperial College Press, London, 2004. L. Cademartiri and G. A. Ozin, Concepts of Nanochemistry, Wiley-VCH, Weinheim, 2009.
9. C. N. R. Rao, A. Muller and A. K. Cheetham, Nanomaterials Chemistry: Recent Developments and New Directions, Wiley-VCH, Weinheim, Germany, 2007.

COURSE NAME: SYNTHETIC ORGANIC CHEMISTRY

COURSE CODE: RCH1003 CREDIT POINTS: 4

Organic synthetic methodology: Organometallic chemistry; green chemistry; multi-component reaction, nanotechnology, sonochemistry, surfactant catalysis.

Advanced organic synthesis : Chiral pool, chiral auxiliary, metal mediated catalysis – asymmetric hydrogenation; Sharpless epoxidation, dihydroxylation, aminohydroxylation of alkenes – metal biocatalysis – organocatalysis – proline mediated aldol reaction and further expansion in the field of organocatalysis, application of photochemistry and radical chemistry in organic synthesis, redox reagents for reactions and rearrangements.

References

1. Clayden, Greeves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2001.
2. M.B. Smith & Jerry March, March's Advanced Organic Chemistry, 5th Edition (2001), John Wiley & Sons, New York.
3. R. O. C. Norman and J. M. Coxon, Principle of organic synthesis
4. S. Warren, Organic synthesis: The disconnection approach
5. W. Carruthers, Modern methods of organic synthesis
6. Advanced Organic Chemistry, Part-A, F.A. Carey and R.J. Sundburg
7. Advanced Organic Chemistry, Part-B, F.A. Carey and R.J. Sundburg

COURSE NAME: SPECIAL TOPICS IN INORGANIC CHEMISTRY

COURSE CODE: RCH1004 CREDIT POINTS: 4

I. Bonding in Transition Metal Complexes: Crystal field theory and splitting in O_h and T_d systems, Term symbols, Russel-Saunders states, Orgel and Tanabe-Sugano diagrams, Magnetic properties of transition metal complexes, Spin-orbit coupling, Magnetic moments of metal complexes with crystal field terms of A, E and T symmetry.

II. Metal Organic Framework (MOF) Materials: designing, synthesis and structure property relationships, chiral MOFs, selective catalysis, CH_4/H_2 storage, CO_2 capture, and selective gas adsorption.

III. Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones, Borazines and silicates. Application of zeolites.

IV. Supramolecular Sensors: Noncovalent interactions, Molecular recognition, Different types of receptors, Supramolecular host design, Binding of cations, anions and neutral molecules.

References:

1. Huheey, J. E., Keiter, E. A., & Keiter, R. L. (1993). Inorganic chemistry: Principles of structure and reactivity, Addison-Wesley Pub. Co., New York.
2. Shriver, D. F., Atkins, P. W. & Langford, C. H. Inorganic Chemistry, 2nd Ed., Oxford Univ. Press (1998).
3. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, 6th Edition (1999), John Wiley & Sons, New York.
4. James E. Mark, Harry R. Allcock, Robert West, Inorganic Polymers, 2nd Edition, Oxford University Press.
5. Lehn, J. M. Supramolecular Chemistry: Concepts & Perspectives Wiley-VCH (1995).
6. Atwood, J. L. & Steed, J. W. Supramolecular Chemistry: A Concise Introduction John Wiley & Sons (2000).

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3	PHP101	COMPUTER APPLICATIONS AND QUANTATIVE METHODS	4	100	C		
FACULTY PAPER (SPECIFIC)							
4	PHP001	COSMOLOGY	4	100	M		
4	PHP002	STATISTICAL MECHANICS	4	100	M		
4	PHP003	ENVIRONMENTAL RADIATION	4	100	M		
4	PHP003	ASTROPHYSICS	4	100	M		
4	PHP005	MICROWAVE AND ANTENNA WAVE PROPAGATION	4	100	M		
4	PHP006	THEORETICAL TECHNIQUES IN PARTICLE PHYSICS	4	100	M		
4	PHP007	PHYSICAL METEOROLOGY	4	100	M		
4	PHP008	SEMICONDUCTOR PHYSICS	4	100	M		
4	PHP009	MATERIAL SCIENCE	4	100	M		

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III. Normal, Revolutionary, Quantitative, and Qualitative Research Methods. Learning from Qualitative and Quantitative Research. Data Collection, Generation of Data using Qualitative Methods: (Individual Interviews, Focus groups, Observations, Self-Study, Action Research), Sources of Quantitative Data, Analyzing Quantitative Data, Pros and Cons of Qualitative research, Comparing Quantitative and Qualitative Research, Example and Distinction, Important Difference, Qualitative research, Descriptive Versus Analytical, Conceptual Versus Empirical, Decision-oriented versus Conclusion-oriented,

IV. Process of literature Survey, Advantages and Pitfalls. The Internet as a Medium for Research, Availability of Scientific Research Information, Problems Encounter, Features of Conducting Research through Internet, New Challenges to Researchers, Potential Advantages of Online Questionnaire, Potential Difficulties, Preservation of References, Assessing the Current Status.

V. Ethics in Research, Computer Ethics, Some areas of Research Ethics, Essential information required for authority, Author Responsibilities, What is not acceptable? What are Plagiarism and Self-Plagiarism, Other Types of Ethical Violations, How Journals Detect and Handle Problem Papers? Example, Reasons for possible Plagiarism, appropriate authorship.

VI. Seminar, Oral Report, Quotation, Points to be Remembered in Preparing an Oral Report, Write-up of the oral presentation, Art of writing and layout of Research Paper or Article or Ph. D. Thesis. Main Text, End Matters, Content of work.

References:

11. Ander May, R., Meyer, V., Van Rys, J., Kemper, D., & Sebranek, P. (2016). The College Writer: A Guide to Thinking, Writing, and Researching, MIT Press.

12. Gustavii, B. (2014). How to Write and Illustrate a Scientific Paper. New York, NY: Cambridge.

13. Kothari, C.K. (2015). Research Methodology – Methods and Techniques. New Age International, New Delhi.

14. Krishnswamy, K.N., Shivkumar, AppaIyer, &Mathiranjan M. (2013). Management Research Methodology: Integration of Principles, Methods, and Techniques. Pearson Education, New Delhi.

15. G. Vijaylakshmi and C. Sivapragasam (2008). Research Methods: Tips and Techniques. MJP Publishers, Chennai.

COURSE NAME: RESEARCH AND PUBLICATION ETHICS

COURSE CODE: RPD1002 **CREDIT POINTS: 2**

I. PHILOSOPHY AND ETHICS

a. Introduction to philosophy: definition, nature and scope, concept, branches
b. Ethics: definition, moral philosophy, nature of moral judgements and reactions

II. SCIENTIFIC CONDUCT

a. Ethics with respect to science and research
b. Intellectual honesty and research integrity
c. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
d. Redundant publications: duplicate and overlapping publications, salami slicing
e. Selective reporting and misrepresentation of data

III. PUBLICATION ETHICS

a. Publication ethics: definition, introduction and importance
b. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
c. Conflicts of interest
d. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
e. Violation of publication ethics, authorship and contributorship
f. Identification of publication misconduct, complaints and appeals
g. Predatory publishers and journals

IV. OPEN ACCESS PUBLISHING

a. Open access publications and initiatives
b. SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies
c. Software tool to identify predatory publications developed by SPPU

V. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

VI. PUBLICATION MISCONDUCT

a. Subject specific ethical issues, FFP, authorship
b. Conflicts of interest
c. Complaints and appeals: examples and fraud from India and abroad
d. Use of plagiarism software like Turnitin, Urkund and other opensource software tools

VII. DATABASES AND RESEARCH METRICS

a. Indexing databases
b. Citation databases: Web of Science, Scopus, etc.

VIII. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score

a. Metrics: h-index, g index, il 0 index, altimetric

References:

1. Bird, A. (2006). Philosophy of Science. Routledge.

2. MacIntyre, Alasdair (1967). A Short History of Ethics. London.

3. P. Chaddah (2018). Ethics in Competitive Research: Do not get scooped; do not get plagiarized.

4. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009). On Being a Scientist: A Guide to Responsible Conduct in Research (Third Edition). National Academies Press.

5. Resnik, D. B. (2011). What is Ethics in Research & Why is it Important. National Institute of Environmental Health Sciences.

6. Beall, J. (2012). Predatory Publishers Are Corrupting Open Access. Nature, 489(7415), 179–179.

7. Indian National Science Academy (INSA) (2019). Ethics in Science Education, Research and Governance.

COURSE NAME: Computer Applications and Quantitate Methods

COURSE CODE: PHP 101 CREDIT POINTS: 4

I. Computer applications

Basic of Computer Operating System: Using Windows – Directory structures – command structure. Word Processing: Basics of Editing and Word processing. Numerical analysis. Figure Plotting: Figure insertions in documents. Web Browsing for Research: Usage of Webs as a tool for scientific literature survey. Preparing presentations: Research papers : Using word processing software – MS Word/Latex/others; Usage of packages (e.g. ORIGIN; EXCEL, Minitab) for data analysis; Curve Fitting: Linear and Non-linear fitting of data, Seminar presentations – Power point for oral and poster presentations

II. Quantitate Methods

Introduction to Statistics - Probability Theories - Conditional Probability, Poisson Distribution, Binomial Distribution and Properties of Normal Distributions, Estimates of Means and Proportions; Chi-Square Test, Association of Attributes - t-Test - Standard deviation - Co-efficient of variations. Correlation and Regression Analysis. Introduction to statistical packages, plotting of graphs.

III. Computer usage for collecting/analyzing data

Simulations using fortran/C/Mathematica/Matlab/Mathcad: Numerical calculations, Mathematical operations, in-built functions, Equation solving, matrices, differentiation, integration, series, limits. Graphics including 3D plots.

IV. Problem solving using analytical and numerical methods

Vector calculus; Vector spaces, Linear transformations, Self-adjoint and unitary transformations, Inner product, orthogonality and completeness, matrices, similarity transformations, Eigenvalues and Eigenvectors of Hermitian and Unitary transformations, diagonalization using analytical and numerical methods. Linear differential equations and introduction to Special functions (Hermite, Bessel, Laguerre and Legendre); Solutions of differential equations using numerical techniques like Runge-Kutta method and other predictor-corrector methods Fourier series, Fourier and Laplace transforms; Numerical evaluation Elements of complex analysis: Cauchy-Riemann conditions, Laurent series-poles, residues and evaluation of integrals.

References:

1. Computer based Numerical Methods 3rd Ed. Prentice Hall India 1980, V. Rajaraman
2. The C++ Programming Language/Addison. B. Stroustrup, 4th edition, Wesely
3. Mathematica, S. Wolfram, Addison. Wesely, 1991
4. Application of the Monte Carlo Method, K. Binder, Springer 1984
5. An Introduction to Computer Simulation Methods, H.Gould and J. Toobochnlik, Addison Wesley, 1996.
6. Computational Physics , Mark Newman CreateSpace Independent Publishing Platform, 2012
7. Linear Algebra , Kenneth M Hoffman Prentice Hall India Learning Private Limited; 2 edition (2015)

COURSE NAME: COSMOLOGY

COURSE CODE: PHP1001 **CREDIT POINTS: 4**

Qualitative ideas of the large scale structure of the universe; Standard Cosmology, Friedmann metric, Hubble law; Observational Parameters: deceleration parameter, equation of state parameter, red-shift parameter, etc; temporal history for different curvatures, abundance of lighter elements, cosmic microwave radiation, cosmological singularity; Dark energy and Dark matter, observational evidence, models with cosmological constant, dynamical origin of cosmological constant, Inflationary models, structure formation (qualitative), Late time accelerating universe, ΛCDM model.

COURSE NAME: STATISTICAL MECHANICS

COURSE CODE: PPH1002 **CREDIT POINTS: 4**

Thermodynamics and Statistical Mechanics: Partition function, Free energy, internal energy and entropy, Fluctuations; Phase Transitions: Liquid-gas, order-disorder, order parameter; correlation function; continuous and discontinuous transitions; Landau's theory of continuous transitions; continuity of entropy; discontinuity of specific heat; singularities of order parameter and partition function; mean-field theory, Critical exponents, scaling and fluctuations of order-parameter; electronic, thermal and magnetic properties of the system; theoretical approach to the explanation of the experimental observations; Non-conventional superconducting materials: Definition, characteristics, experimental observations; Theoretical review, possible mechanism of non-conventional superconductivity.

COURSE NAME: ENVIRONMENTAL RADIATION

COURSE CODE: PHP1003 **CREDIT POINTS: 4**

Environmental Radiations & Interaction of Radiations with Matter; Sources of Environmental Radiations; Dosimetric Quantities, Units and Applications; Measurement Techniques; Counting Statistics and Error Prediction; Biological Effects of Ionizing Radiations & Risk Models; Effects of Non-ionizing E-M Radiations; Standards and Regulations

COURSE NAME: ASTROPHYSICS

COURSE CODE: PHP1004 **CREDIT POINTS: 4**

Magnitudes, Absolute and relative magnitudes, distance modulus, Hertzsprung – Russel diagram, the Sun, its structure and different properties, derivation of Hydro-dynamical equilibrium (General Relativistic), Newtonian star, stellar structure, stellar evolution, white Dwarf, Chandrasekhar mass limit, Neutron star, Black holes, Pulsar, X-ray sources, Techniques of Astrophysical DATA Analysis.

COURSE NAME: MICROWAVE AND ANTENNA WAVE PROPAGATION

COURSE CODE: PHP 005 **CREDIT POINTS: 4**

I. PROPAGATION OF ELECTROMAGNETIC WAVES: The Ionosphere, Basic Equation of Electromagnetic wave, Fading; Modes of Propagation: Ground - Wave, Ionosphere Wave, Space Wave. Troposphere Scatter, Duct, Multi-hop. Definitions: virtual Height, Skip Distance, Maximum Usable Frequency Lowest Usable Frequency Optimum Working Frequency.

II. ANTENNA FUNDAMENTALS: Antenna Parameters. Radiation Resistance, Radiation Pattern, Bandwidth, Beam width, Polarization, Beam Area, Beam Efficiency, Radiation Intensity, Directivity, Directive Gain, Power Gain, Antenna Efficiency, Different Apertures, Aperture Efficiency, Effective Height.

III. ANTENNA STRUCTURE AND CHARACTERISTICS: Point source Antenna Concept, Short-dipole, its Resistance. Folded Dipole, Log Periodic Antenna, Introduction to End Fire and Broad side antenna with Derivation.

IV. ANTENNA FOR SPECIAL APPLICATION: VHF/UHF antennas Helical Antenna Parabolic Reflector Antenna Horn Antenna Turnstile Antenna, Super turnstile Antenna Micro strip Antenna Slot and Patch Antenna Terrestrial mobile communication antennas Base station antenna Mobile station antenna Mobile tower trees Smart antennas: Needs and Application. Signal transmission and reception techniques from satellites, Indian satellites, Common Weather Radar and Doppler Radar, Ionospheric and tropospheric disturbances, Transient luminous events, observing techniques of astronomical objects; Solar, Jovian and Extraterrestrial signal receiving methods.

COURSE NAME: THEORETICAL TECHNIQUES IN PARTICLE PHYSICS

COURSE CODE: PHP 006 **CREDIT POINTS: 4**

Covariant Perturbation theory, Feynman Rules for spin 0 and spin ½ particles and their applications / Like groups: SU(2), SU(3) and SU(5) and their applications : Higgs Mechanism and Goldstone theorem and its application in gauge theories.

COURSE NAME: PHYSICAL METEROLOGY

COURSE CODE: PHP 007 **CREDIT POINTS: 4**

Structure and composition of the atmosphere; Equation of state for dry and moist air, Humidity Parameters, Virtual Temperature, Standard Atmosphere, Barometric Altimetry, Potential Temperature, Pseudo- adiabatic Process, Equivalent Temperature, Equivalent Potential Temperature, Clausius – Clapeyron Equation, Thermodynamic Diagrams. Uses of thermodynamic diagrams: LCL, LFC, Precipitable Water Vapor, Role of Convective Available Potential Energy (CAPE) and Convective Inhibition Energy (CINE) in thunder storm development. Hydrostatic Equation and its application; Stability and Instability of Atmosphere; Black Body Radiation and Laws of Radiation, Absorptivity and Emissitivity, Atmospheric absorption of solar radiation and infrared radiation, Raleigh and Mie scattering. Radiative transfer and global energy balance.

COURSE NAME: SEMICONDUCTOR PHYSICS

COURSE CODE: PHP 008 **CREDIT POINTS: 4**

Semiconductors in equilibrium and under non-equilibrium conditions, ionization coefficient for impurities, Fermi level and IMREF, recombination and generation of carriers, concept of lifetime, Schokley-Read-Hall theory, surface recombination. Vapour phase epitaxy, molecular beam epitaxy, impurity, impurity diffusion, ion implantation technique. Silicon solar cells, short-circuit current, open circuit voltage, fill factor, efficiency, factors limiting the performance of solar cells. Hetero-junctions, ideal low dimensional systems, density of states for an ideal electron gas in one, two and three dimensions, quantum wells, quantum wires and quantum dots, super lattices.

COURSE NAME: MATERIAL SCIENCE

COURSE CODE: PHP1009 **CREDIT POINTS: 4**

Applied Crystallography in material science: Lattice, Crystal systems, unit cells. Coordinates of position in the unit cell, Zones and zone axes. Crystal geometry. Symmetry classes and point groups, space groups. Glide planes and screw axes, space group notations, Stereographic projections, Standard projection of crystals. Crystal Structure, Crystal defect, Classification of materials: Crystalline & amorphous materials, high T_c superconductors, alloys & composites, Ceramics materials, Polymer and Composites materials, Liquid Crystal Preparation techniques of materials: Single crystal growth, zone refining, epitaxial growth. Melt-spinning and quenching methods, sol-gel, polymer processing. Preparation of ceramic materials; Fabrication, control and growth modes of organic and inorganic thin films: different technique of thin film preparations: Basic principles Characterization of materials: Thermal Analysis, Microscopic Method, Electron microscopy and optical analysis, Spectroscopy. Nanoscience and technology: Synthesis Technique, Synthesis of Nanomaterials, Characterization.

References:

1. Statistical Physics of Particles, Mehran Kardar (Cambridge University Press, 2007).
2. Statistical Mechanics, Kerson Huang (2ndEdition, Wiley-India, 2008).
3. Statistical Mechanics, R.K. Pathria (Butterworth-Heinemann, 1996).
4. Statistical Physics, Vol. 5 in Course in Theoretical Physics, L. D. Landau and E. M. Lifshitz, Elsevier.
5. Introducing Nuclear Physics, K. S. Krane (Wiley India., 2008).
6. Nuclear Physics – Theory & Experiments, R.R. Roy & B.P. Nigam (New Age International, 2005)
7. Nuclear Physics in A Nutshell, C. A. Bertulani (1st Ed., Princeton University Press, 2007)
8. Concept of Nuclear Physics, B. L. Cohen (McGraw – Hill, 2003)
9. Nuclear Physics, S. N. Ghoshal (First edition, S. Chand Publication)
10. Nuclear & Particle Physics : An Introduction, B. Martin (Willey, 2006)
11. Introduction to Elementary Particles, D. Griffiths (Academic Press, 2n Ed.2008)
12. Physics and Engineering of Radiation Detection by Syed Naeem Ahmed(Academic Press 2007)
13. Nuclear and Particle Physics , A.B. Bhattacharya, R. Bhattacharya an R. Raha, NCBA, 2018

Department of Earth Sciences and Remote Sensing
Syllabus for Ph.D. Coursework

Sl. No.	Course code	Course	Credit points	Full marks	Course type#	Total credits	Total marks
UNIVERSITY PAPER (COMMON)							
1	RPD1001	RESEARCH METHODOLOGY	4	100	C		
2	RPD1002	RESEARCH AND PUBLICATION ETHICS	2	50	C		
FACULTY PAPER (OPTIONAL)							
3	PMT1002	Mathematics for Remote Sensing	4	100	M		
4	PRS1001	Fundamental of Remote Sensing and Digital Image Processing	4	100	M	**14**	**350**
5	PRS1002	Geographic Information System (GIS) and GNSS	4	100	M		
6	PRS1003	Fundamentals of Photogrammetry	4	100	M		
7	PMT2001	Mathematice-II	4	100	M		
8	PRS2001	Advanced Digital Image Processing	4	100	M		
9	PRS2002	Advanced GIS & Cartography	4	100	M		
10	PPH2003	Large to small bodies	4	100	M		
11	PRS3001	Quantitative Geoinformatics	4	100	M		
12	PRS3002	Geoinformatics in Watershed Management	4	100	M		
13	PRS3003	Geoinformatics in Natural Hazards and Disaster Management	4	100	M		
14	PRS4001	Geoinformatics in Retail Management	4	100	M		

 # C = COMMON COURSE; EC = ELECTIVE COURSE

COURSE NAME: RESEARCH METHODOLOGY

COURSE CODE: RPD1001 **CREDIT POINTS: 4**

Contents:

I. Research-Definition, Objectives of Research, What Makes People do Research? Qualities of a good Researcher, Limitations of Research, Views of Researchers, Scientific method of Research, Importance of Research, Illustrations of Research.

II. Process of Research. Research Methods, Research Methods versus Research Methodology. Fundamental or Basic Research and Examples, Applied Research and Examples, Differences between Basic Research and Applied research. Difference between Approach and Validity, Reliability versus Unbiased and objective, Research structured enquiry, Research Design.

III. Normal, Revolutionary, Quantitative, and Qualitative Research Methods. Learning from Qualitative and Quantitative Research. Data Collection, Generation of Data using Qualitative Methods: (Individual Interviews, Focus groups, Observations, Self-Study, Action Research), Sources of Quantitative Data, Analyzing Quantitative Data, Pros and Cons of Qualitative research, Comparing Quantitative and Qualitative Research, Example and Distinction, Important Difference, Qualitative research, Descriptive Versus Analytical, Conceptual Versus Empirical, Decision-oriented versus Conclusion-oriented,

IV. Process of literature Survey, Advantages and Pitfalls. The Internet as a Medium for Research, Availability of Scientific Research Information, Problems Encounter, Features of Conducting Research through Internet, New Challenges to Researchers, Potential Advantages of Online Questionnaire, Potential Difficulties, Preservation of References, Assessing the Current Status.

V. Ethics in Research, Computer Ethics, Some areas of Research Ethics, Essential information required for authority, Author Responsibilities, What is not acceptable? What are Plagiarism and Self-Plagiarism, Other Types of Ethical Violations, How Journals Detect and Handle Problem Papers? Example, Reasons for possible Plagiarism, appropriate authorship.

VI. Seminar, Oral Report, Quotation, Points to be Remembered in Preparing an Oral Report, Write-up of the oral presentation, Art of writing and layout of Research Paper or Article or Ph. D. Thesis. Main Text, End Matters, Content of work.

References:

1. Ander May, R., Meyer, V., Van Rys, J., Kemper, D., & Sebranek, P. (2016). The College Writer: A Guide to Thinking, Writing, and Researching, MIT Press.
2. Gustavii, B. (2014). How to Write and Illustrate a Scientific Paper. New York, NY: Cambridge.
3. Kothari, C.K. (2015). Research Methodology – Methods and Techniques. New Age International, New Delhi.
4. Krishnswamy, K.N., Shivkumar, AppaIyer, &Mathiranjan M. (2013). Management Research Methodology: Integration of Principles, Methods, and Techniques. Pearson Education, New Delhi.
5. G. Vijaylakshmi and C. Sivapragasam (2008). Research Methods: Tips and Techniques. MJP Publishers, Chennai.

COURSE NAME: RESEARCH AND PUBLICATION ETHICS

COURSE CODE: RPD1002 **CREDIT POINTS: 2**

I. PHILOSOPHY AND ETHICS

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

II. SCIENTIFIC CONDUCT

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

III. PUBLICATION ETHICS

1. Publication ethics: definition, introduction and importance
2. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributorship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

IV. OPEN ACCESS PUBLISHING

1. Open access publications and initiatives
2. SHERPA/RoME0 online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU

V. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

VI. PUBLICATION MISCONDUCT

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad
4. Use of plagiarism software like Turnitin, Urkund and other opensource software tools

VII. DATABASES AND RESEARCH METRICS

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

VIII. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score Metrics: h-index, g index, il 0 index, altimetric

References:

1. Bird, A. (2006). *Philosophy of Science*. Routledge.
2. MacIntyre, Alasdair (1967). *A Short History of Ethics*. London.
3. P. Chaddah (2018). *Ethics in Competitive Research: Do not get scooped; do not get plagiarized*.
4. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2009). *On Being a Scientist: A Guide to Responsible Conduct in Research* (Third Edition). National Academies Press.
5. Resnik, D. B. (2011). *What is Ethics in Research & Why is it Important*. National Institute of Environmental Health Sciences.
6. Beall, J. (2012). *Predatory Publishers Are Corrupting Open Access*. Nature, 489(7415), 179–179.
7. Indian National Science Academy (INSA) (2019). *Ethics in Science Education, Research and Governance*.

COURSE NAME: MATHEMATICS FOR REMOTE SENSING

COURSE CODE: PMT1002 **CREDIT POINTS: 4**

Course Content:

Module 1: Basic Calculus

Limits and Continuity: Introduction, Limit of a function, Definition of limit of a func- tion - definition), examples. Differentiation: Partial derivatives, Total differential, Con- ditions for a function to be a maximum or a minimum at a point, Errors and approxi- mation, Successive Differentiation. Integration: Elementary integration, Integration by parts, Simple definite integrals.

Module 2: Differential Equations

Differential Equations: Some basic definitions, Order and degree, Equations in sep- arable form, Homogeneous equations, Linear Differential equations, exact equations, application.

Module 3: Vector Algebra

Vector Algebra: Position vector, scalar product, vector product, geometrical inter- pretation, gradient of scalar function, divergence and curl of vector function. Vector Spaces: Definition and Examples, Subspaces, Linear dependence, Basis and Dimension, Sum and Direct Sum, Quotient spaces, Linear Transformations: Kernel and Image ofa Linear Transformation, Rank and Nullity of a Linear Transformation

Module 4: Matrices and Determinant

Matrices and Determinant: Introduction to matrices, Types of matrices, Operation on matrices, Transpose of a matrix, Matrix Multiplication, Determinants, Properties of determinants, Product of determinants, Minors and co-Factors, Adjoint of a square matrix, Singular and non-singular matrices, Inverse of a matrix, Solution of system of linear of

equations using matrix method, Cramer's rule, Characteristic equation and roots of a square matrix, Cayley–Hamilton theorem Simple problems on practical applications of RS and GIS

Module 5: Numerical Methods

Numerical Methods: Errors in approximation, Absolute, Relative and percentage er- rors. Solution of algebraic and transcendental equations: Bisection method, Newton Raphson method, Systems of simultaneous Equations: Inversion method, Gauss elimi- nation method, Gauss Jordon method, LU decomposition method, Iterative methods: Jacobi method and Gauss-Seidel method. Numerical Integration: General quadrature formula, Trapezoidal rule, Simpson's 1/3rd rule, Expression for corresponding error terms.

References:

1. P.K. Sharma, "Remedial Mathematics (1st Edition)", Nirali Prakashan.
2. M.C. Potter, J. Goldberg, "Mathematical Methods (2nd Edition)", Prentice Hall.
3. K.E. Atkinson, "An Introduction to Numerical Analysis (2nd Edition)", Wiley-India.
4. S.D. Conte, Carl de Boor, "Elementary Numerical Analysis - An Algorithmic Approach (3rdEdition)", McGraw-Hill.

COURSE NAME: FUNDAMENTAL OF REMOTE SENSING AND DIGITAL IMAGE PROCESSING

COURSE CODE: PRS1001 **CREDIT POINTS: 4**

Course Content:

Module 1: Introduction to Remote Sensing

Introduction: History of Remote Sensing, Remote sensing components, Sources of Energy, EMS and Radiation, Black body and associated laws, Stefan-Boltzman law, Wien's law, Kirchhoff's law etc., Interaction of EMR with Atmosphere—Scattering, Refraction, Absorption, Transmission, Atmospheric windows, Interaction of EMR with Earth Surface—Spectral reflectance curves, Radiation Calculation, Spectral, Spatial, Temporal and Radiometric resolutions.

Module 2: Platforms and Sensors

Platforms and Sensors: Orbital movement and Earth coverage. Sun-synchronous and Geosynchronous satellites, Active and passive sensors, PAN, Multi High resolution and Hyper spectral Sensors, Thermal and Microwave sensors, Sensors characteristics. Satel- lites and their Specifications: LANDSAT, Pleiades, SPOT5/6/7, ENVISAT, World- View, Quickbird, GeoEye, Sentinel-1/2, ASTER, RADARSAT, IRS, IKONOS, Car- tosat etc.Referencing scheme of satellite system (path/row calculation).

Module 3: Thermal and Microwave Remote sensing

Thermal and Microwave Remote sensing: Infrared Scanners, Scatterometer, Thermal Properties of Terrain, Thermal IR Environmental Considerations, Thermal Infrared and Thermal Scanners, Microwave Remote sensing concepts: Backscattering, Range Direction, Azimuth Direction, Incident Angle, Depression Angle, Polarization, Dielec- tric Properties, Surface Roughness and Interpretation, Speckle and Its Reduction, Ap- plications of optical, thermal and microwave remote sensing.

Module 4: Digital data products and their characteristics

Digital data products and their characteristics: Digital data Formats: BIL, BSQ, BIP, TIFF, Geo-TIFF, HDF, NetCDF, Ground segment organization, Pre-processing, Ref- erencing Scheme, Data product generation, Data product output medium, Open Data Sources, Colour image generation, Initial data statistics, Histogram and Scatter plot, Mosacing.

Module 5: Ground Truthing and Remote Sensing Applications

Ground Truthing and Remote Sensing Applications: Importance of Ground Truthing in Remote Sensing, Ground Truth Radiometer (GTR), Radiometric Calibration, Digital and Analog Methods, Spectral Response Patterns: Soil, Vegetation, Rocks and Water, RS Applications in Agriculture, Forestry, Land cover/Land use, RS Applications in Water resources and Earth Science.

References:

1. R.C. Gonzales and R.E. Woods, "Digital Image Processing (2nd Edition)", Pearson Education.
2. T.M. Lillesand and R.W. Kiefer "Remote Sensing and Image Interpretation (4th Edition)",John Wiley.
3. P.M. Mather "Computer Processing of Remotely Sensed Images (1st Edition)", John Wiley.
4. J.R. Jensen "Remote Sensing of the Environment – An Earth Resources Perspective", PearsonEducation.
5. J. George "Fundamentals of Remote Sensing", Universities Press.
6. S.K. Sinha "Fundamental of Remote Sensing and GIS", Ayushman Publication House.
7. Q. Weng "Advances in Environmental Remote Sensing: Sensors, Algorithms, and Applica-tions", CRC Press.
8. F.F. Sabins "Remote Sensing: Principles and Applications (3rd Edition)", Waveland PressInc.
9. R.G. Reeves "Manual of Remote Sensing", American Society of Photogrammetry and RemoteSensing, Falls Church, Virginia, USA.

GEOGRAPHIC INFORMATION SYSTEM (GIS) & GNSS

COURSE CODE: PRS1002 **CREDIT POINTS: 4**

Course Content:

Module 1: Introduction

Introduction: Spatial and Non-spatial Data, Basic Database Management System, Co- ordinate reference system, Spheroid, Datum, Projection, Introduction to GIS, Types of Data in GIS, Geographical data models: Raster and vector models, Data Structure: Attribute structuring - data storage strategies, Data indexing, Geometric structuring, Topology- Concepts, Rules, spatial queries.

Module 2: Capture and Edit

Capture and Edit: Digitizing, digitizing into layers, Scanning, Errors and quality con- trol of raster data: Spatial data, quality of GIS output, Sources of error in spatial data, Factors affecting the reliability of spatial data, Faults stemming, Accuracy tolerance, The epsilon band, Root mean square error, Error propagation analysis. Statistical approach to error propagation in numerical modeling.

Module 3: Raster and Vector Operations and Integration

Raster and Vector Operations and Integration: Local, Focal, Zonal and Global Operations, AND, OR, NOT integration, overlay with attributes, attribute passing, Map logic – Boolean and logical operators, arithmetic operators, overlaying quadtrees, query operations. Neighbourhood operations in raster: Spatial aggregation Filters (low pass and high pass). Slope and aspect, Spread computation, Seek Computation, Buffering, View shed analysis, Network analysis.

Module 4: Surveying

Survey: Types of survey, Leveling Booking and reduction methods, Numerical on leveling, Traversing, Basic construction and adjustments, Numerical on traverse computation. Principles of Total Station survey.

Module 5: GNSS

GNSS: History, Fundamental concepts, What makes GNSS – satellites, receivers, post processing software's, Sources of error in a GNSS system, Different terminology used in GPS survey, How it works – concepts, measuring distance, Accuracy of receivers, Surveying with GNSS – space segment, codes used, GNSS constellation, ground control segment, user segment, Modes of operation – single point positioning, relative position- ing, kinematic positioning, static positioning, Differential GPS.

References:

1. P.A. Burrough and R.A. McDonnell, "Principles of Geographical Information systems", OxfordUniversity Press.
2. C.P. Lo and K.W. Yeung, "Concepts and Techniques of Geographic Information Systems",Pearson Education.
3. P.A.Longley, M.f.Goodchild, D.J.Maguireand D.W. Rhind, "Geographical Information systemand Science (3rd Edition)", John Wiley.
4. S. Sekhar and H. Xiong, "Encyclopedia of GIS", Springer International Publishing.
5. T. P. Kanetkar, S. V. Kulkarni, "Surveying and Levelling Vol I and II", Vidyarthi GrihaPrakashan.

COURSE NAME: FUNDAMENTALS OF PHOTOGRAMMETRY

COURSE CODE: PRS1003 **CREDIT POINTS: 4**

Course Content:

Module 1: Introduction to photogrammetry

Introduction to photogrammetry: Historic development, types, significance. Areal Camera: optical aspects and components of aerial camera, types of aerial camera, Cam- era calibration. Fundamentals of Air Photo: Controlling factors of aerial photography; Classification of air photo, elements of air photo, applications of air photo.

Module 2: Basic Geometry of air photo

Basic Geometry of air photo: Geometric aspects of air photo; determination of scale, photographic resolutions; photographic displacement, height determination from dis- placement; Exterior and interior orientation, bundle block adjustment, space intersec- tion and space resection; aerial flight planning. .

Module 3: Stereoscope and stereoscopy

Stereoscope and stereoscopy: Basic concepts, types of stereoscopes, needs of stereoscopy and stereo pair; floating mark principal and stereoscopic depth perception, stereoscopic parallax; depth, height, co-ordinate determination from parallax.

Module 4: Photographic film and filter

Photographic film and filter: Aerial films, types of aerial films; general characteristics of photographic emulsions; Concepts of film exposer, film density, film speed, opacity andtransmittance, film resolution; characteristics curve; Black and white film emulsion, spectral sensitivity of black and white film, black and white film processing, negative to positive sequence of black and white film; film filters, types; Colour film, concept of colour, spectral sensitivity of colour film, processing of colour film; colourer film, spectral sensitivity of colour IR film, colour IR film processing.

Module 5: Terrain modelling with UAV

Terrain modelling with UAV: Digital Photogrammetric Images from UAV and associated concepts, UAV flight planning, coverage types, processing methods, Recent trends in its application, automated aerial triangulation: concepts, solutions, analy- sis, Photogrammetry work-stations, Review of available software.Principles of Digital Photogrammetry: Hardware and software requirements, Image measurement, Orien- tation procedure, Epipolar geometry, Aerotriangulation, Block adjustment, Satellite stereo images, Mosaics of DTM and ortho images.

References:

1. F.H. Moffitt and E.M. Mikhail, “Photogrammetry (3rd Edition)”, Harper and Row Publisher.
2. P.R. Wolf and B.A. Dewitt, “Elements of Photogrammetry”, McGraw-Hill.
3. T. Luhmann, S. Robson, S. Kyle and J. Beohm, “Close Range Photogrammetry and 3DImaging”, Gruyter Inc.
4. E.M. Mikhail, J.S. Bethal and J.C. McGlove, “Introduction to Modern Photogrammetry”,John Wiley and Sons.

COURSE NAME: BASIC REMOTE SENSING & GIS AND ITSAPPLICATION

COURSE CODE: PRS1004 **CREDIT POINTS: 4**

Course content:

Module 1: Remote Sensing

Remote Sensing: Definition -Historical Components of Remote Sensing Principles methods of remote sensing - Active and Passive remote sensing - Remote Sensing platforms-Electromagnetic radiation- Spectrum- Block body radiation – planks law – Stefan – Boltzmann law – satellites classification – based on orbit- sun synchronous and Geosynchronous based on purpose Earth Resources satellites, communication satellite Weather satellites Spy satellites Sensors Description of sensor in landscape, spot, IRS series and current satellites- Radar SLAR-and SAR.

Module 2: EMR Interactions

EMR Interactions: Interaction with atmosphere Scattering of EMR Raleigh, Mie, Non Selective and Raman Scattering Bach scattering Speckle EMR Interaction with water and Ozone Atmospheric windows and its significance EMR interaction with the earth surface materials Radiance, irradiance, Absorbed and Transmitting energy – reflectance- Specular- and diffuse surface- Spectral signature – and curves EMR interaction with soil Resolution Spectral, Spatial, Radiometric, and Temporal.

Module 3: Resources Engineering

Resources Engineering: Characteristics of Digital satellite image enhancement Filtering Applications of Aerial photographs and satellite imageries – merits – Limitations– Water resources – watershed management – Urban Studies – Flood Management- Fishing Forestry etc.

Module 4: Geographic Information System

Geographic Information System: GIS – Components of GIS – Hardware, Software and Organizational Context – Data – Spatial and Non Spatial – Maps – Types of Maps – Projection – Types of Projection - Data Input – Digitizer, Scanner – Editing – Rasterand Vector data structures – Comparison of Raster and Vector data structure – Analysis using Raster and Vector data – Retrieval, Reclassification, Overlaying, Buffering – Data Output – Printers and Plotters

Module 5: Miscellaneous Topics

Miscellaneous Topics: Visual Interpretation of Satellite Images – Elements of Interpretation - Interpretation Keys Characteristics of Digital Satellite Image – Image enhancement – Filtering – Classification - Integration of GIS and Remote Sensing – Applicationof Remote Sensing and GIS – Urban Applications- Integration of GIS and Remote Sensing – Application of Remote Sensing and GIS – Water resources – Urban Analysis – Watershed Management – Resources Information Systems

References:

1. A. Reddy, “Remote Sensing and Geographical Information Systems”, BS Publications.
2. P.H. Anand, “Principles of remote Sensing and Geographical Information Systems”, Sri VenkateswaraPublishers.
3. T.M. Lillesand and R.W. Kiefer, “Remote sensing and Image, Interpretation”, John Wiley.
4. P.A. Burrough, “Principle of GIS for land resource assessment”, Oxford University.

COURSE NAME: MATHEMATICS II

COURSE CODE: PMT2001 **CREDIT POINTS: 2**

Course content:

Module 1: Basic Probability Theory

Classical and Axiomatic definition of Probability (elementary properties), Conditional probability, Bayer's theorem and related problems. Probability Distributions: Definition of random variable; Continuous and discrete random variables; Probability density function, probability mass function for single variable only; Distribution function and its properties (without proof), Examples; Definitions of Expectation, Variance, properties and examples. Some important discrete distributions: Binomial, Poisson. Continuous distributions: Normal; Determination of Mean, Variance and standard deviation of the distributions, Application to RS.

Module 2: Statistical Concepts in RS

Meaning, Scope and importance of Statistics, application of Statistics in RS; Collection of data - sampling methods; random and systematic method; source of data - primary and secondary Organization of data - array, frequency, class intervals, histograms, and distribution, Presentation of Data: Tables, Diagrams, Grouped data and ungrouped data, Geographical data: discrete and continuous series, scales of measurement, Measures of Central Tendency - mean, median, mode, quartiles, Moments, Skewness, Kurtosis, Measures of Dispersion – absolute dispersion, relative dispersion Correlation: meaning, scatter diagram, standard deviation, variance, Measures of correlation – Karl Pearson's method (two variables ungrouped data), Spearman's rank correlation methods.

Module 3: Descriptive Statistics

Descriptive Statistics- Data Visualization-Sampling distribution-Confidence Interval-Hypothesis Testing- Correlation; Simple linear Regression-Method of Least Square-Analysis of variance, Chi-square test, t-test, F-test, Z-test.

Module 4: Geo-statistics

Mean center of population and temporal shift, Bi-variate Multiple correlation and regression, Correlation analysis Scatter Diagram Residual mapping, T-test, Z-Score, Root Mean Square Error, Principal Component analysis.

Module 5: Statistical applications in GIS

Surface Modeling: Spatial autocorrelation, Role of Interpolation, Methods of Interpolation – Global and Local Deterministic Methods, Moving Averages, Inverse Distance Interpolation, Optimal Interpolation using Geostatistics, Variogram and its use for In- terpolation, Interpolation by Kriging – Ordinary Kriging, Block Kriging, Non-Linear Kriging, Stratified Kriging, Co-Kriging, Universal Kriging, Probabilistic Kriging Factor and cluster analysis.

References:

1. P.K. Sharma, "Remedial Mathematics (1st Edition)", Nirali Prakashan.
2. M.C. Potter, J. Goldberg, "Mathematical Methods (2nd Edition)", Prentice Hall.
3. K.E. Atkinson, "An Introduction to Numerical Analysis (2nd Edition)", Wiley-India.
4. S.D. Conte, Carl de Boor, "Elementary Numerical Analysis - An Algorithmic Approach (3rdEdition)", McGraw-Hill.

COURSE NAME: ADVANCED DIGITAL IMAGE PROCESSING

COURSE CODE: PRS2001 **CREDIT POINTS: 4**

Course Content:

Module 1: Digital Image Fundamentals

Elements of visual perception: Structure of human eye; Image formation in the eye; Brightness adaptation discrimination. Image Sensing and acquisition: Image acquisition using a single sensor; Image acquisition using sensor strips; Image acquisition using a sensor array; A simple image formation model. Image sampling and quantization: Basic concepts in sampling and quantization; Rep- resenting digital image; Spatial and intensity resolution; Image re sampling and inter- polation. Basic relationship between pixels: Neighbours of a pixel; Adjacency, connectivity, regions and boundaries; Distance measures

Module 2: Intensity Transformation and Spatial Filtering

Some basic intensity transformation functions: Contrast Stretching; Image Negatives; Log Transformation; Power-Law (Gamma) Transformation; Piecewise-linear Trans- formation Functions.

Histogram Processing: Histogram Equalization; Histogram Matching (Specification); Local Histogram Processing; Using Histogram Statistics for Image Enhancement.

Fundamentals of Spatial Filtering: The mechanics of spatial filtering; Spatial Corre- lation and Convolution; Vector representation of Linear Filtering; Generating Spatial Filter Masks. Smoothing and sharpening Spatial Filtering: Smoothing linear filters; Order-statistics (Nonlinear) filters; Using the second derivative for Image Sharpening-The Laplacian; Unsharp Masking and High-boost Filtering; Using first-order derivatives for (Non linear) image sharpening-The Gradient.

Module 3: Digital Image Classification

Principal Component Analysis (PCA), Discriminate Functions. Unsupervised Classification: K-Means Clustering, K-Medoid Clustering; Fuzzy C-Means Clustering; EL- BOW METHOD and SILHOUETTER METHOD; Iso-Data Clustering; Hierarchical clustering: Single Linkage, Complete and Average Linkage; K-NN Clustering; DB- SCAN. Supervised Classification: parallelepiped classification; Minimum Distance to Mean Classifier; Maximum Likelihood Classifier; K-Nearest Neighbor (K-NN) Algorithm; Ac- curacy Assessment and Error Matrix.

Module 5: Image Compression

Fundamentals: Coding redundancy; Spatial and temporal redundancy; Irrelevant information; Measuring Image Information; Fidelity Criteria; Image Compression models; Image formats; Containers and Compression Standards. Some basic compression models: Huffman Coding; Golomb Coding; Arithmetic Coding; LZW Coding; Run-Length Coding; Symbol-Based Coding; Bit-Plane Coding; Black Transform Coding.

References:

1. R.C. Gonzalez, R.E. Woods, "Digital Image Processing (3rd Edition)", Pearson.
2. S Jayaraman, S. Essakkirajan, T. Veerakumar, "Mathematical Methods", Tata McGrow Hills.
3. A. McAndrew, "Introduction to Digital Image Processing with Matlab", Thomson CourseTechnology.
4. A.K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India.
5. J.C. Russ and J.C. Russ, "Introduction to Image Processing Analysis", CRC Press.
6. J.R. Jensen "Remote Sensing of the Environment – An Earth Resources Perspective", PearsonEducation.
7. J.C. Russ and F.B. Neal "The Image Processing Handbook (7th Edition)", CRC Press.
8. G.S. Srivastava "An Introduction to Geoinformatics", McGraw Hill Education.

COURSE NAME: ADVANCED GIS & CARTOGRAPHY

COURSE CODE: PRS2002 **CREDIT POINTS: 4**

Course content:

Module 1: Spatial data generation through interpolation

Spatial Analysis: Concept and objectives, Spatial interpolation- Concepts, Types, Important interpolation techniques used in GIS- IDW, Spline, Trend surface analysis, Voronoi Polygon, TIN Interpolation accuracy estimation, Applications of spatial interpolation; Terrain Mapping and analysis- Concepts of DEM, DTM and DSM.

Module 2: Web GIS

Web GIS: Basics of Computer Networking, Network communication models, Inter net protocols, Information exchange process, Basic requirement of Distributed GIS, Dis- tributed web mapping architecture from OGC, Web server, Map server, Appli- cation services, Database Middleware, Static map publishing, Interactive.

Module 3: Python Fundamentals

Python language fundamentals: Introduction, Working with data types and structures, Working with numbers, Working with variables and naming, Writing statements and expressions, Using strings, Using lists, tuples and dictionary, Working with Python objects, Using functions, Using methods, Working with strings, Working with lists, Working with paths, Working with modules, Controlling workflow using conditional statements, Controlling workflow using loop structures, Getting user input, Commenting scripts.

Module 4: Python in Geospatial analysis

Geo-processing using Python, Explore Manipulate spatial data, Working with rasters, Listing rasters, Describing raster properties, Working with raster objects, Working with the ArcPy Spatial Analyst module, Using raster functions to work with NumPy arrays.

Module 5: Digital Cartography

Introduction: Concept, development, advantages and disadvantages.Data sources: Digital Database, Cartographic database concepts. Geographical varables and their specifications, Graphic design: Components of graphic map design, Lettering of maps, Methods and guidelines, Theory of colour and pattern, Choosing colour and patterns, Isarithmic mapping. Introduction to digital cartography, Types of Maps, Map Scale, Line thinning algorithms, Changing cartography environment, Pro- cessing Cartographic data: Data ordering, Compilation, Cartographic generalization, Symbolisation of qualitative data, Symbolisation of quantitative data: Point, Line, Area, Volume. Map reproduction.

References:

1. M.S. Monmonier, “Computer Assisted Cartography: Principles and Prospects”, Prentice Hall.
2. A. H. Robinson, “Elements of Cartography (6th Edition)”, John Wiley & Sons.
3. E. Raise, “ Principles of Cartography”, McGraw-Hill.
4. R.G. Cromley, “Digital Cartography”, Prentice-Hall.
5. S. Annadurai, R. Shanmugalakshmi, “Fundamentals of Digital Image Processing.”, PearsonEducation.
6. P.A. Burrough, ”Principles of Geographic Information System for Land Resources Assessment.”, Oxford University Press.
7. K. Chang “Introduction to Geographic Information Systems (5th Edition)”, McGraw-Hill.
8. D. J. Peuquet, D. F. Marble, “Introductory Readings in Geographic Information System”,Taylor and Francis.

COURSE NAME: GIS, GNSS AND ITS APPLICATIONS

COURSE CODE: PRS2003 **CREDIT POINTS: 4**

Course content:

Module 1: Introduction

Spatial and Non-spatial Data, Basic Database Management System, Co-ordinate reference system, Spheroid, Datum, Projection, Introduction to GIS, Types of Data in GIS, Data sources. Conversion on data.

Module 2: Geographical data models

Geographical data models: Raster and vector models, Data Structure: Attribute structuring - data storage strategies, tabular, hierarchical, relational, network, database organization, object orientation, Data indexing, Geometric structuring, Topology- Concepts, Rules, spatial queries, Various GIS software. Coordinate transformation.

Module 3: Raster and Vector Operations and Integration

Raster and Vector Operations and Integration: Local, Focal, Zonal and Global Oper-ations, AND, OR, NOT integration, overlay with attributes, attribute passing, Map logic – Boolean and logical operators, arithmetic operators, overlaying quadtrees, Neighborhood operations in raster: Spatial aggregation, Filters (low pass and high pass).Slope and aspect, Spread computation, Seek Computation, Buffering, View shedanalysis.

Module 4: Digital Cartography

Digital Cartography, Cartographic data, Map scale, Types of Maps, graphic map design, Data ordering, Compilation, Cartographic generalization, Symbolisation of qualitative data, Symbolisation of quantitative data.

Module 5: GNSS

GNSS : Fundamental concepts, What makes GNSS – satellites, receivers, How it works– concepts, measuring distance, Accuracy of receivers, Surveying with GNSS – space segment, codes used, GNSS constellation, ground control segment, user segment, Modesof operation – single point positioning, relative positioning, kinematicpositioning, static positioning, Differential GPS.

References:

1. P.A. Burrough and R.A. McDonnell, "Principles of Geographical Information systems", OxfordUniversity Press.
2. C.P. Lo and K.W. Yeung, "Concepts and Techniques of Geographic Information Systems",Pearson Education.
3. P.A.Longley, M.f.Goodchild, D.J.Maguireand D.W. Rhind, "Geographical Information systemand Science (3rd Edition)", John Wiley.
4. S. Sekhar and H. Xiong, "Encyclopedia of GIS", Springer International Publishing.
5. T. P. Kanetkar, S. V. Kulkarni, "Surveying and Levelling Vol I and II", Vidyarthi GrihaPrakashan.

COURSE NAME: QUANTITATIVE GEOINFORMATICS

COURSE CODE: PRS3001 **CREDIT POINTS: 4**

Course Content:

Module 1: Geometry of the Earth

Shape of the Earth: Conceptualisation of Planet Earth- The Earth's physical surface, Concept of Geoid, Reference Ellipsoid/Spheroid.Ellipsoidal model, Oblate Spheroid, Reference Spheroid and Concept of datum.Typical Datum used in geospatial analysis, Indian Geodetic Datum, Indian Mean Sea Level. Introduction to different spheroid /ellipsoid systems with special reference to Everest and WGS-84 - Geometric Constants.

Module 2: Coordinate system used in Geoinformatics

Coordinate System used in Geodesy: Geodetic and Geocentric Coordinate System, Earth Cantered Earth Fixed Coordinate System; Spherical trigonometry – concept of great circle and spherical triangle and trigonometry, Coordinate Transformations; Co- ordinate System used by Survey of India (, , H), Map Projections: Defining Map, Projection Systems, Azimuthal, Conical and Cylindrical projections with emphasis on Lambert Conformal Conic (LCC) and Universal Transverse Mercator (UTM) projection.

Module 3: Spatial data analysis

Spatial Analysis: Concept and objectives, Spatial interpolation- Concepts, Types, Important interpolation techniques used in GIS- IDW, Kriging, Spline, Trend surface analysis, Concept of Semivariogram, Voronoi Polygon, TIN Interpolation accuracy estimation, Applications of spatial interpolation; Terrain Mapping and analysis- Concepts of DEM, DTM and DSM, Watershed and View shed analysis, Terrain Mapping, Least Cost Path analysis; Network Analysis: layer-based and object-oriented approaches to network analysis, Nature and utility of network data models, basic representations of node and link tables, Network Data representation,

analysis and modelling (multidmensional GIS-T models), Applications and problems – Shortest routeing, travelling salesman problem, vehicle routing problem, Closest facility, facility location allocation and spatial interaction models., Utility Network analysis.

Module 4: Quantitative modeling for information generation

GIS Models and Modeling: Concepts of GIS models and modeling, Objectives, Typical GIS data models, Elements of GIS modeling, Typical GIS modeling. Quantitative Remote Sensing: Optical Image band organization for information extraction, Supervised image enhancement and extraction of environmental variables, Study in geometry of spectra plot, image simulation and predictive approach, SAM, SVM and LSMM for information extraction; Thermal and Microwave image analysis for environmental mon-itoring.

Module 5: Quantitative modeling for information generation

Multi-criteria Decision Analysis: Elements and Structure of MCDA and SDSS, Multi- objective and Multi-attribute analysis, Evaluation Criteria; Decision Alternatives and Constraints; Quantitative Models to calculate criteria weight and alternative rank estimation- Ranking and Rating (SMART), Entropy method, Analytical Hierarchy Process (AHP), Fuzzy AHP, TOPSIS method, CRITIC. Spatial Statistics in GIS: Pattern Analysis - Nearest neighbour, Ripley's K function, Spatial Autocorrelation, Cluster Analysis: Hotspot Analysis, LISA, Measuring Geographical Distribution - Mean Centre, Directional Ellipse, Standard Distance, Modeling Spatial relationship – GWR, OLS, Multiple correlation and Regression.Statistical Mapping: Dot map, Choropleth Mapping and types, Isopleth Mapping, Dasymetric Mapping, Atlases and Hyper maps, Anamorphic Mapping.

References:

1. J.B. Campbell, "Introduction to Remote Sensing (3rd Edition)", The Guilford Press.
2. R.K. Gupta, S. Chander, "Principles Of Geoinformatics", Jain Brothers.
3. A. Ghassem, "Theory and Applications of Optical Remote Sensing", John Wiley and Sons.
4. C.P.Lo, A.K.W.Yeung, "Concepts and Techniques of Geographic Information Systems", Pren-tice Hall of India.
5. D.J. Magwire, M.F. Goodchild and D.M. Rhind Ed, "Geographical Information Systems: Prin- ciples and Applications", Longman Group, U.K.
6. J.R. Jensen "Remote Sensing of the Environment – An Earth Resources Perspective", Pearson Education.
7. J.C. Russ and F.B. Neal "The Image Processing Handbook (7th Edition)", CRC Press.
8. Kangtsung Chang "Introduction to Geographic Information Systems", Tata McGraw Hill,New Delhi.

COURSE NAME: GEOINFORMATICS IN WATERSHED MANAGEMENT

COURSE CODE: PRS3002 **CREDIT POINTS: 4**

Course Content:

Module 1: Concept of Watershed

Concept and definition of watershed; Quantitative characterization of Watershed; classification of Watershed; Watershed deterioration and consequents; Watershed restoration.

Module 2: Watershed Management and Planning

Watershed management: Problems and prospects; Objectives and principles of Water- shed management; Components of Watershed management; Watershed prioritization; Land capability and watershed based land use planning; Hydro-geomorphic interpretation techniques for targeting ground water potential Zones; Budgeting water in a watershed.

Module 3: Watershed Conservation measures

Soil erosion control and conservation; Rain water conservation and harvesting; Micro irrigation system; People's participation in watershed management; Introduction to India-WRIS Bhuvan Project; River Valley Project (RVP); Hill Area Development Programme (HADP); National Watershed Development Programme for Rainfed Agriculture (NWDPRA); Watershed management programmes, guideline and policies in India; West Bengal Accelerated Development of Minor Irrigation Project (WBADMIP); Role of NGOs in watershed development.

Module 4: Application of Geoinformatics in Watershed Management

Overview of RS and GIS applications in watershed management; Digital Terrain analysis for watershed characterization; Geospatial modeling for soil erosion assessment in watershed; Land use modeling, planning and site suitability analysis; Dam site selection and canal alignment, Drought flood assessment and potentiality zonation, soil moisture mapping; Crop water, Crop yield and acreage estimation; CROPWAT modeling.

Module 5: Water resource management

Surface water mapping and monitoring; surface run-off estimation using SCS CN method; Ground water targeting; Water harvesting site selection and artificial rechargezonation; Water quality assessment and indexing.

Text/Reference Books:

1. V.R.Desai, A. Mishra, A. Kumar, "Watershed planning and management ICAR lecture series",www.agrimoon.com.
2. John G. Lyon, "GIS for Water Resource and Watershed Management", (1st Edition)", CRCPress.
3. Xuan Zhu, "GIS for Environmental Applications: A practical approach", (1st Edition)", Rout-ledge.
4. J.V.S. Murthy, "Watershed Management", (2nd Edition)", , New Age Publishers.

COURSE NAME: GEOINFORMATICS IN NATURAL HAZARDS AND DISASTER MANAGEMENT

COURSE CODE: PRS3003 **CREDIT POINTS: 4**

Course Content:

Module 1: Fundamental Overview of natural hazards and disaster

Introduction to natural hazards, impact and mitigation in Global and Indian context; Types of hazards and disasters, characterization, zonation of hazards, Hazard Inventory, Hazard assessment at different scale, Natural and human induced disasters; Introduction to vulnerability and risk, Risk assessment, Multi hazard risk assessment, socio-economic and physical aspects of vulnerability and elements of risk mapping, assessment, and reduction strategies.

Module 2: Disaster Management and Institutional Framework-I

Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management, Early Warming Systems, building design and construction in highly seismic zones, retrofitting of buildings.

Module 3: Disaster Management and Institutional Framework-II

Community preparedness: Pre and Post disaster preparedness, Stakeholder participation, Effectiveness of Social capital; Institutional arrangements for disaster management: NDMA, SDMA, DDMA, NDRF; Strengthening of NDMA and SDMA; Survival skill adopted during and after disaster.

Module 4: Application of Geoinformatics in Hazard

Overview of RS and GIS applications in Hazard and Disaster susceptibility zonation, mapping and management; Flood hazard susceptibility zonation using Interval Rough number (IRN), Analytical Network Process (ANP), HEC RAS, Multi Attribute Border Approximation Comparison (MABAC).

Module 5: Disaster susceptibility zonation and mapping

Landslide hazard susceptibility zonation using Frequency Ratio Model (FRM), Ordered Weighted Average Model (OWAM), Analytical Hierarchical Process (AHP); Drought assessment using SEBAL and different drought indices; Mapping of Coastal vulnerablebility due to extreme events and coastal erosion using optical and Microwave RS data and Digital shoreline analysis system (DSAS).

Text/Reference Books:

1. Brian Tomaszewski, "Geographic Information Systems (GIS) for Disaster Management", Rout-ledge.
2. Bai Tian, "GIS Technology Applications in Environmental and Earth Sciences", CRC Press.
3. R.K. Gupta, Subhash Chander, "Principles Of Geoinformatics", Jain Brothers.
4. Joseph L. Awange, John B. Kyalo Kiema, "Environmental Geoinformatics: Monitoring andManagement", Springe.

COURSE NAME: GEOINFORMATICS IN RETAIL MANAGEMENT

COURSE CODE: PRS4001 **CREDIT POINTS: 4**

Course Content:

Module 1: Introduction

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Module 2: Business Organization

Organization structures, management issues, team management, business policy, out- sourcing, data quality assurance, and change management. Data mining and mining methodologies, descriptive analytics, predictive analytics, predicative modeling, non- linear optimization, and prescriptive analytics as they relate to business analytics.

Module 3: Statistical Analysis

Univariate and Multivariate Statistical methods, Review of probability distribution and data modeling, sampling and estimation methods overview, Trendiness and Regression Analysis: Modeling Relationships and Trends in Data, Mann Kendall trend test.

Module 4: Forecasting Techniques in Retailing

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality.

Module 5: Typical Forecasting Techniques

Regression Forecasting, Monte Carlo Simulation and Risk Analysis, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model, Decision Theory, Decision Making Under Risks, Decision Tree Analysis.

Text/Reference Books:

1. M.J. Schniederjans, D.G. Schniederjans and C. M. Starkey, “Business analytics PrinciplesConcepts, and Applications”, Pearson FT Press
2. James Evans, “Business Analytics”, Persons Education.
3. D. M. Levine, D. F. Stephan, K. A. Szabat and P.K. Viswanatha, “Business Statistics”, Pear-son.